

## Educating through research: an essay on the articulation of practical activities developed in the science lab

ARTICLE

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### Abstract

This production presents a brief account of the experience of using research skills and the importance of scientific practices in the context of the pedagogical and learning activities used at the Josefa Alves Bezerra EEMTI, and in particular the activities adopted in the Science Educational Laboratory. To construct the report, academic research tools appropriate to the objectives of the work were used. The aim is to study how teaching through research is reflected in the educational practice of EEMTI Josefa Alves Bezerra. The study was constructed by investigating the state of the art in pedagogical practice, seeking to reflect on its importance as a learning method. To present the results, qualitative research was used to investigate the quality of the results observed and the construction of the students' scientific trajectory in the productions developed at the school and presented at scientific events. Based on the findings, it is possible to reflect on the need to strengthen research practices with financial and personnel support, produce scientific knowledge to debate teaching and learning, strengthen practice and technological knowledge, as well as recognizing the skills and competences already developed and which justify the presence of scientific research in the school life of the institution.

**Keywords:** Teaching practice. Science education. Technology.

### Educar pela pesquisa: ensaio sobre a articulação das atividades práticas desenvolvidas no laboratório de ciências

### Resumo

A produção apresenta um breve ensaio da experiência da utilização das habilidades de pesquisa e a importância das práticas científicas no contexto das atividades pedagógicas e de aprendizagens utilizadas na EEMTI Josefa Alves Bezerra e em especial nas atividades adotadas no Laboratório educacional de ciências. Para a construção do relato, foram utilizadas as ferramentas de pesquisa acadêmica adequadas aos objetivos do trabalho. O objetivo é estudar como o ensino pela pesquisa se reflete na prática educativa da EEMTI Josefa Alves Bezerra. O estudo se construiu por meio de uma investigação do estado da arte sobre a prática pedagógica buscando refletir acerca da sua importância como

método de aprendizagem. Para a apresentação dos resultados, utilizou-se da pesquisa qualitativa por meio da investigação da qualidade dos resultados observados e da construção da trajetória científica dos alunos nas produções desenvolvidas na escola e apresentadas nos eventos científicos. A partir das constatações é possível refletir sobre as necessidades de fortalecimento das práticas investigativas com apoio financeiro e de pessoal, produzir conhecimento científico para debater o ensino-aprendizagem, fortalecer a prática e o conhecimento tecnológico, além de reconhecer habilidades e competências já desenvolvidas e que justificam a presença da pesquisa científica na vida escolar da instituição.

**Palavras-chave:** Prática de ensino. Educação científica. Tecnologia.

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## 1 Introduction

Nowadays, there is an ever-increasing need for information and knowledge, and progressively people, and especially our students, have access to research resources. To this end, it is also necessary to reflect on how these technologies are used and whether these students are making correct use of these mechanisms.

In this sense, the role of the teacher and the student in the classroom involves motivating research, awakening attention to the richness of the discussion and the taste for knowledge. Thus, a researcher teacher is above all a socializing agent of knowledge, and must act as a mediator between the epistemological relationship of knowledge, the student and the subject of study.

Due to the complexity of the concepts, the need to promote experimentation and the need for a solid understanding of scientific fundamentals, teaching science can be difficult. This means that the implementation of technologies and active methodologies can provide additional resources to make learning more accessible, attractive and effective.

In view of these findings, there is a need to think about how schools promote science education and the meaningful contextualization of the theoretical knowledge they teach. With the adoption of the new high school policy, the intention to make scientific investigation a premise of the teaching-learning process with reach into all areas of knowledge is even more evident.



According to Borges (2002, p. 293) "The quality of the education provided by school systems to children and young people has been the subject of debate for several decades, culminating in calls for reform of these systems and current curricula."

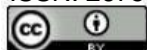
Science teaching needs to be centered on combining a theoretical approach with practical conceptualization, preferably contextualized in the reality and experiences of the students. According to Bueno et al (2008) "If there is no articulation between the two types of activities, that is, theory and practice, the content will not be very relevant to the individual's education or will contribute very little to their cognitive development."

In an attempt to offer a model of education that is reflected in the student's life, in society and in the relationship between the two, education systems and public policies have been promoting reforms that place scientific investigation, research and social practice at the center of the teaching-learning process.

Souza and Dourado (2015) point out that one of the biggest difficulties faced by education at the moment is implementing reforms that keep pace with scientific, technological, social, cultural, economic and environmental advances with the aim of contributing to the development of a more socially and economically just society. The process of reforming education involves many changes, including breaking with structural frameworks and traditional teaching models.

Part of this change in scenario is strengthened by the use of technological resources as a means of improving research tools, as a way of enhancing the scope of experimentation practices and as a way of adapting the educational process to the globalization movement.

Demo (2010) highlights the importance of scientific investigation in the process of creation and research. In the author's view, students should be encouraged to develop skills that allow them to broaden their repertoire after understanding a certain piece of knowledge and to continue investigating that subject, bringing a deeper or even original contribution to that topic.





"Students are not condemned to copying things that have been copied. They can also, within their natural limitations, work on scientific texts, with the aim of becoming capable of producing their own, which allows them to continue learning and keeping up to date throughout their lives. It is one thing to absorb content, but quite another to reconstruct it, investing some originality in the process" (2010, p. 16).

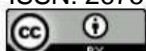
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In other words, it's not just about research and scientific investigation, but about teaching how to research and how to investigate. In the researcher's view, "science education is based primarily on the expectation of a knowledge-intensive society", recognizing the fact that the production of innovative knowledge has increasingly become the decisive factor in terms of development opportunities. It is clear that the way in which individuals acquire and engage with knowledge has undergone a significant transformation as a result of technological advances.

The need to implement technologies and active methodologies in science teaching is justified by the promotion of a more dynamic education that fosters curiosity, research and the practical application of scientific knowledge. These methods can also help to train critical citizens who are prepared for the challenges of the modern world. The conscious use of technological resources, combined with the dynamic interaction between theory and practice, creates an environment conducive to the development of scientific thinking and the formation of critical, reflective citizens prepared for the challenges of the 21st century.

The presence of technological resources is already a concrete reality in all aspects of society, helping humankind in the most diverse activities carried out on a daily basis and contributing to the optimization of time in an increasingly hectic reality immersed in the immediacy of globalization. As is the case in other areas, the effects of innovation in educational processes are noticeable in the results of our education.

In this scenario, it is necessary to understand the distinct and separating effect that access and non-access to these resources can have. Educational systems that have the availability of appropriate scientific methods and incentives for scientific culture guarantee better learning, while students without this access continue to learn according to methods applied in the last century.





In order to overcome this reality using the scarce resources available, it is necessary to make the student the protagonist in the educational processes developed and awaken their interest in scientific culture. This can be achieved by encouraging the use of technology and its resources to solve everyday problems and the assertive use of the universe of research and access to information. In addition to combining these processes with ethical, fair and environmentally friendly practices.

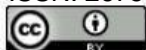
## 2 Methodology

The methodological approach used to develop the study was based on a combination of bibliographical research and a case study, focusing on surveying the historical context of the scientific projects and actions already developed at the institution and the investigative activities based on the active methodology that are present in the school's teaching practices. Consolidated academic research methods were used to achieve the objectives of the study.

The study began with a comprehensive review of the academic literature on the importance of science education, highlighting the most relevant research and existing theoretical models. The data collected was analyzed qualitatively to identify the effect of pedagogical practice on the institution's results. The research findings were compiled into a report that included a discussion on the importance of science education and recommendations for effective pedagogical practices. This study followed the ethical principles of research, ensuring that informed consent was obtained and that data was not used in a harmful or discriminatory way.

In order to draw up the institution's scientific memory and survey reports on current methodological practices, we used the various possibilities of scientific research, understood by Fonseca (2012, p. 21) as:

"an activity aimed at solving problems. Thus, it starts from a doubt or a problem, seeking an answer or solution, using the scientific method. Research is also a way of obtaining knowledge and discoveries about a particular subject or fact."





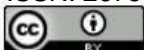
Pursuing the construction of knowledge and seeking to achieve the objectives of the work, the various bibliographic sources that served to support and reference the research were consulted. According to Fonseca (2012, p. 21), the purpose of this practice "is to put the researcher in direct contact with everything that has been written, said or filmed on a given subject" and that "bibliographical research is not a mere repetition of what has already been said or written on a certain subject, but rather provides an opportunity to examine a subject from a new perspective or approach, reaching innovative conclusions."

The use of hands-on activities in school environments needs to go beyond verifying a theory. According to Borges (2002), scientific research needs to be built into laboratory practices based on the possibility of testing hypotheses for the phenomena studied, arousing enjoyment for research and not just the reproduction of a practice with results that have already been predicted. According to Borges (2002, p. 295), "The laboratory can provide excellent opportunities for students to test their own hypotheses about particular phenomena, to plan their actions and carry them out in such a way as to produce trustworthy results."

In developing the activities at the Science Laboratory (LEC) at the "Escola de Ensino Médio em Tempo Integral Josefa Alves Bezerra" (Josefa Alves Bezerra Full-Time High School), we always seek the lead role of the student in the construction, development and verification of the stages that make up scientific research in each area of knowledge covered. Among the practices already developed in the 2022 school year, the study of the properties of matter should be highlighted. In this activity, the students were encouraged to think about how to verify the authenticity of a piece of gold jewelry, based on the concepts covered about the general and specific properties of matter.

This study aims to improve our understanding of the role of science education in the formation of critical and innovative individuals, as well as providing useful insights for pedagogical practice and the development of educational policies.

### 3 Results and Discussion





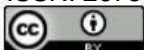
The need to make students truly active in the process of constructing knowledge has long been debated in various areas of reflection on basic education in Brazil. In this sense, the student takes ownership of the learning process in a more meaningful way and becomes capable of living critically in society. Nasário (2018, p. 13) points out that "decision-making and critical positioning on the part of the student only happens with their active participation in the discussions of subjects debated in class, in science lessons."

This strengthening of student activity in the construction of knowledge is advocated by various researchers based on the adoption of teaching methods with a focus on Science, Technology, Society and the Environment ("CTSA"). According to Nasário (2018, p.13), the main objective associated with working with CTSA "is to promote the scientific literacy of basic education students". Based on scientific literacy and, therefore, the condition to read knowledge critically and scientifically, Sipavicius and Sessa (2019, p.8) defend the importance of the practice and that "investigative teaching is based on the reflexive use of the products and processes of an area of human knowledge".

According to Borges (2002, p. 293) "The quality of education provided by school systems for children and young people has been the subject of debate for several decades, culminating in calls for reform of these systems and the curricula in force." With the adoption of the new secondary education policy, the intention to make scientific investigation a prerequisite of the teaching-learning process has become even more evident, with outreach into all areas of knowledge.

For Demo (2010), science education is essential to prepare students not only to absorb existing information, but also to enable them to reconstruct knowledge and develop continuous learning skills. "For science education to have a proper structural impact, the first condition is to reconstruct other learning strategies that are not instructional and reproductive." (2010, p. 22).

From these findings, it can be seen that methodologies based on student protagonism and the construction of knowledge through projects, debates and experiments are fertile spaces for the emergence of solutions to everyday problems and for the development of skills in the appropriation and application of technological knowledge.



During the lesson on the properties of matter, the students analyzed the material and discussed the conditions of the equipment and reagents available in the laboratory. They then chose to use the material's density calculation to check its authenticity against tabulated values. At first, the students seemed unable to solve the problem, but as they analyzed the situation, they also took a liking to the activity and soon came up with a proposal for the investigation.

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**Figure 1 - Development of the hands-on lesson: properties of matter**



Source: Elaborated by the author

Activities were also carried out to investigate the heat involved in chemical reactions and the possible ways of measuring the energy involved in these processes.

**Figure 2 - Development of the hands-on lesson: properties of matter**



Source: Elaborated by the author





In the second part of the study, the context of the institution's participation in scientific productions and fairs focused on the area was considered. During the pedagogical activities developed at the institution and based on the guiding documents of the educational model adopted, various activities to encourage scientific production are implemented in the approaches to the areas of knowledge and in the curricular units (electives). The results of these productions are presented to the school community at culminating events and through participation in scientific events, such as the Ceará Científico.

In this event, the institution has played a significant role, winning prizes at regional level (Regional Education Development Coordination - CREDE) and qualifying for the state competition. In 2016, the school won second place in the area of Languages and Codes with the literary newspaper project, and in the area of Natural Sciences with an alternative project for blood typing (ABO System). In 2018, the areas of Natural Sciences and Mathematics came third.

In 2019, the school once again took an active part by presenting projects at the scientific event. It took third place in the Mathematics area with projects developed in the Mathematics Club under the guidance of teacher Rodrigo Bezerra, and first place in the Human Sciences area with teacher Fábio Ferreira's project on living in the semi-arid region.

An analysis of the institution's successful track record in participating in editions of Ceará Científico and other events that value scientific productions in education shows the importance of teaching through the development of projects in making teaching and learning effective and ensuring the theoretical transposition of knowledge with scientific research in solving problems in the daily lives of students and the school community.

Research in science teaching is fundamental to the growth and improvement of teaching techniques. It helps educators find out more about how students learn and which teaching strategies are most effective. Research can help develop innovative and effective methods that encourage students and facilitate the learning process.

## 4 Conclusions





When investigating the importance of science education in teaching and learning in the academic literature, it was possible to see how several scholars point to scientific investigation practices, the approach to content based on concrete problems and experimentation as successful methodologies. Firstly, by helping students to develop skills related to scientific investigation, such as identifying problems, formulating hypotheses, drawing conclusions and designing experiments.

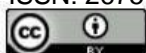
The results of these productions were presented to the school community and were well evaluated by the public, constituting a successful hands-on experience of using science education to solve everyday problems. They were also pedagogical activities in which the students themselves were able to use elements of scientific literacy to develop the proposed interventions.

When analyzing the history of participation in scientific events, we noticed an increase in the interest of students and the school community in participating in scientific olympiads and events. This highlights the importance of science education in building trust in science and institutions, especially in dealing with misinformation and promoting a positive relationship between science and the public.

Knowing the importance of the Research Educator's practice in the classroom, it is necessary to improve it, as this offers the possibility of discovering different methodologies. It also encourages educators and students to seek out new truths in their daily lives, always committed to quality education.

This finding is also confirmed in the observation of school performance and the students' familiarization with scientific language and the production of projects and interventions that are manifested in the solution of everyday problems, as well as improving their critical perception of how society works.

Finally, we would like to highlight the importance and impact of the actions developed in the project on the students' perception of the presence of technology in our lives and the need to use it to make the right decisions. This aims to mitigate environmental problems, understand social aspects and their impacts, ensure conscious consumption and





waste disposal practices, as well as enhancing the educational practices that are developed by observing the elements of science education.

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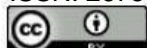
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